XIX International Conference on Water Resources
CMWR 2012
University of Illinois at Urbana-Champaign
June 17-22, 2012

Bayesian characterization of the uncertainty associated with geomorphic, habitat and water quality data in Vermont streams.

Nikolaos Fytilis, University of Vermont, 802-656-7789, nfitilis@uvm.edu

1. Nikolaos Fytilis, University of Vermont
2. Donna Rizzo, University of Vermont

Management alternatives for hydrological and environmental systems need to be assessed in the presence of uncertainty. Environmental managers often use classification tools to identify and forecast the behavior of these complex systems. In such applications, there often exists a hierarchy of data such that the decision-making process should include the alternative sources of uncertainty, either epistemic or aleatoric. We research and develop a new classification neural network that couples a Bayesian classifier with a modified counterpropagation neural network. We use rapid geomorphic assessment protocols (RGA), as well as, rapid habitat assessments (RHA) and water quality data from ~35% (8279 miles) of the total 23000 stream miles of Vermont stream reaches assessed by the Vermont Agency of Natural Resources (VTANR). The ability to characterize streams with high environmental risk is essential for a proactive adaptive watershed management and allows managers to classify river network sensitivity in various contexts and on different spatial scales. Previous data analysis dealt with uncertainty using fuzzy logic and identified the influence of watershed scale parameters on hydrological processes that alter the physical structure and habitat values of streams. Our newer approach integrates Bayesian statistics to examine the effect of similar geomorphic parameters and water quality data on biodiversity.
Counterpropagation neural network, originally developed by Hecht-Nielsen [1987], is used to classify the sensitivity of river networks in various contexts (erosion hazard mitigation, habitat restoration and conservation). The procedure is data-driven, and therefore does not require the development of site-specific, process-based stream models, or sets of if-then-else rules associated with expert systems. This enables a truly adaptive management approach that embeds expert opinion into the prior probability distribution. The RGA and RHA comprise multiple data types from stream reach cross-sections and corresponding estimates of stream habitat biodiversity. Additional water quality data for the same streams provides a training set that enables accurate classification of habitat integrity at the reach scale that (1) more fully utilizes the existing VTANR geomorphic, habitat and water quality data, and (2) simultaneously identifies and reduces uncertainties associated with multiple stakeholders' goals and outcomes.